

DSN Scheduling System

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The Deep Space Network (DSN) Scheduling Group provides the operationally oriented administrative support necessary for the effective scheduling of the DSN. The scheduling system plus the levels of schedules will be explained in this article.

I. Introduction

The DSN Scheduling Group, assigned to the Control Center Operations Section, has the direct responsibility and authority for scheduling Network operational resources based upon allocations, constraints and guidelines as set forth by the National Aeronautics and Space Administration, the Office of Space Tracking and Data Systems, and the Telecommunications and Data Acquisition and Deep Space Network Management.

Effective utilization of Deep Space Network (DSN) resources depends upon the requirements and plans of all users being known far enough in advance to accomplish orderly planning. DSN Scheduling provides the users of the Network with the accumulated requirements in a logical and timely manner.

The accomplishment of this task requires the ability to forecast gross requirements for a minimum of three years by means of the DSN Forecast (Fig. 1), refine these requirements into a three-month schedule by means of the DSS Utilization Plan, and further refine these activities in an eight-week schedule (DSN 8-Week Operations Planning Schedule), thereby

resulting in a detailed conflict-free weekly schedule (DSN 7-Day Operations Schedule). Figure 2 is a functional flow chart for scheduling and depicts the sequence of events.

Resource allocation is accomplished through a scheduling system comprising three levels of schedules; long-, mid- and short-range.

II. Long-Range Resource Allocation Schedule

The DSN Forecast, published quarterly, represents the combined resource requirements by the various network users for the upcoming three years. It also depicts one year of history comparing project requirements versus actual support provided. As the time approaches three months prior to the planned event, these requirements must be shown in greater detail. Whereas the DSN Forecast depicts Network user requirements in four-week increments by longitude and size of antenna, these requirements must now be delineated as to day and facility. This is accomplished via the DSS Utilization Plan, which is commonly referred to as the X-Chart, and the DSN/FPSO Conflict Resolution Operations Planning Schedule.

III. DSN/FPSO Conflict Resolution Operations Planning Schedule

Multiple users independently submitting requests for tracking resources twenty-four hours a day, seven days a week, creates an environment that can result in scheduling concurrent activities at the same facility. A joint DSN/Flight Project Support Office (FPSO) Scheduling Board is convened weekly to resolve these conflicts. The board comprises a representative from FPSO, DSN, each flight project, and other users of DSN Resources, as required. DSN Scheduling publishes a weekly DSN and FPSO Conflict Resolution-Operations Planning Schedule. The objective of this publication is to identify these conflicts as far in advance as possible. The following information is provided:

- (1) A list of user codes that are used to identify each user. These codes ensure the consistency and uniformity that is essential in data manipulation (Table 1).
- (2) A station loading table (Table 2). Each station requires a minimum of twenty hours per week for preventive maintenance. These tables enable scheduling personnel to ascertain if adequate maintenance has been allocated and if there is any remaining time available.
- (3) A DSS Utilization Plan or X-Chart (Table 3). This plan outlines by month and day the prime activities that are scheduled at each station. It does not reflect noninterference-basis activities or maintenance not requiring facility downtime.
- (4) A DSS Delta X-Chart (Table 4). This chart reflects additions or deletions occurring to the Scheduling data base as compared to the last issue of the DSN and FPSO Conflict Resolution-Operations Planning Schedule.
- (5) A Data Base listing that is month, day, and time sensitive, listing each activity at each station (Table 5) with identified conflicts.

IV. Mid-Range Resource Allocation Schedule

The X-Chart and the DSN/FPSO Conflict Resolution Planning Schedule have proven to be excellent vehicles for spanning the gross requirements outlined in the DSN Forecast and the refined requirements listed in the DSN 8-Week Operations Planning Schedule. The X-Chart depicts each activity by day and facility. Changes made to the X-Charts have varying degrees of impact on the users. The closer they are made to the scheduled event, the greater the impact on the facilities and projects with low priorities. The impact upon the facilities prohibits proper internal activity planning for personnel train-

ing, engineering change order implementation, and maintenance. Projects cannot properly utilize the residual time which is available after these last minute changes. Analysis has shown that, due to the dynamic nature of the various projects, the greatest number of changes normally occur five to six weeks prior to the scheduled event.

The primary objective of the DSN 8-Week Operations Planning Schedule is to assist all users of Network Resources in the refinement and development of the forthcoming 7-Day Schedule. It is published on a four-week cycle and contains current planned Network resource allocation planned for two weeks in advance of the publication date through the next sequential eight weeks.

V. Short-Range Resource Allocation Schedule

The DSN 7-Day Operations Schedule provides for the control and accountability of all activities occurring in the DSN. As an operations schedule, it contains the resources and configuration requirements necessary for minute-to-minute DSN Operations Support. The objective of the 7-Day Schedule/Forecast are two-fold. The first and primary objective is that of providing a detailed, timed sequence of events for the operation of the Deep Space Network in the forthcoming week. The second objective is to provide all concerned parties with the latest projected tracking and support activities for the week following the published 7-Day Schedule. This Forecast provides the DSN Facilities and all other principals with the information required so that they may plan their manpower and other resource allocation in the most efficient manner. There are many factors affecting DSN resource allocation. There are those which are known and can be factored into the generation of the 7-Day Schedule; unfortunately there are also those which cannot be accurately predicted. Therefore, provision must be made for accomplishing orderly real-time changes to the published 7-Day Schedule. Real-time scheduling provides a controlled method for coordinating and documenting all real-time changes throughout the Network.

VI. Real-Time Scheduling

Changes to the published 7-Day Operations Schedule may be disruptive and counterproductive to the Network Resource Allocation System if not closely monitored and controlled. Although each originator of a change request is attempting to maximize his productive use of the Network, the sum of all inputs may be a net loss for everyone. To minimize the impact on resource allocation and maintain high network productiv-

ity, all requested changes are reviewed, assessed for impact, and closely controlled. This is accomplished by the real-time scheduling process.

Change requests to the published 7-Day Operations Schedule are submitted to DSN Scheduling for approval. Scheduling reviews each request for impact to other users, verifying concurrence when required, and availability of Network resources. When these requirements are met, the change requests are

processed. Users of Network resources should only submit these changes to ensure achievement of operational objectives.

The only changes to the published schedule that are accomplished through the Network Operations Control Team are changes required as a result of real-time activities such as spacecraft emergencies, major Network failures, resource conflict resolution, and necessary adjustment to provide committed flight support.

Table 1. User codes for the DSS Utilization Plan

Code	Activity
VKG	Viking Project and related DSN preparation testing and training activities
VK1	Viking 1 tracking pass
PNV	Pioneer Project and related DSN preparation testing and training activities
P06	Pioneer 06 tracking pass
P07	Pioneer 07 tracking pass
P08	Pioneer 08 tracking pass
P09	Pioneer 09 tracking pass
P10	Pioneer 10 tracking pass
P11	Pioneer 11 tracking pass
P12	Pioneer 12 tracking pass
HEL	Helios Project and related DSN preparation testing and training activities
HE1	Helios 01 tracking pass
VGR	Voyager Project and related DSN preparation testing and training activities
VG1	Voyager 1 tracking pass
VG2	Voyager 2 tracking pass
R/A	Radio Astronomy: OSS, RAES, OSF and OSTA activities
A/S	Advance Systems: OSTDS activities
HRS	Host Country Radio Science – Spain or Australia
RRR	Downtime for maintenance/reconfiguration
ENG	DSN engineering support
DSN	DSN preparation testing and training activities

Table 2. DSN/FPSO station loading for weeks 9, 10, 11, and 12

Week	DSS	Total sched.	4 ± hr gaps	Maintenance	Special ^a	Conflicts
9	11	168:00	0:00	29:25	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	168:00	0:00	14:40	32:50	0:00
	42	168:00	0:00	17:45	0:00	0:00
	43	168:00	0:00	23:35	0:00	0:00
	44	168:00	0:00	20:50	0:00	0:00
	61	168:00	0:00	41:50	0:00	0:00
	62	168:00	0:00	47:55	0:00	0:00
	63	168:00	0:00	29:40	0:00	0:00
10	11	149:30	11:20	21:45	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	163:25	0:00	13:20	50:20	0:00
	42	151:00	9:25	26:00	0:00	0:00
	43	164:25	0:00	14:25	0:00	0:00
	44	163:30	0:00	19:00	0:00	0:00
	61	142:30	23:35	28:55	0:00	0:00
	62	125:00	43:00	18:50	0:00	0:00
	63	163:30	0:00	26:30	0:00	0:00
11	11	147:00	12:35	17:20	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	168:00	0:00	16:10	40:00	0:00
	42	142:00	15:25	25:30	0:00	0:00
	43	167:45	0:00	20:00	0:00	0:00
	44	161:15	0:00	21:35	0:00	0:00
	61	155:25	4:25	23:10	0:00	0:00
	62	123:15	43:00	21:15	0:00	0:00
	63	164:35	0:00	19:05	0:00	0:00
12	11	154:30	0:00	14:50	0:00	0:00
	12	168:00	0:00	168:00	0:00	0:00
	14	160:05	0:00	18:20	15:15	0:00
	42	142:05	15:05	17:30	0:00	0:00
	43	168:00	0:00	18:15	0:00	0:00
	44	153:05	0:00	16:45	0:00	0:00
	61	147:15	8:50	17:00	0:00	0:00
	62	125:30	35:05	28:50	0:00	0:00
	63	161:40	0:00	16:10	0:00	0:00

^aSpecial category consists of the following: sole plate maintenance, RTC array maintenance, and bearing maintenance.

Table 3. DSS Utilization Plan (generated 2/6/81)

Week Day Date Month DOY	8							9							10							11							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
DSS-11	HE1	HE1	DSN	HE1	HE1	HE1	HE1	P12	DSN	P11	P12	HE1	HE1	P12	HE1	HE1	P12	R/A	P11	P12	VG1	HE1	HE1	P12	R/A	P11	P12	VG1	HE1
	VG2	VG1	P11	VG1	VG2	VG1	VG1	HE1	R/A	P12	HE1	VG2	VG1	HE1	VG2	VG2	VG1	P12	P12	VG1	VG2	VG2	VG1	VG1	P12	P12	VG1	VG2	VG2
			HE1						HE1									HE1											
DSS-12	VG1	P11	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR
	DSN	P12	VGR	VGR	P10	P10	P10	R/A	DSN	P12	P12	R/A	R/A	VGR	P12	P10	HE1	RRR	P10	P10	P11	VGR	P09	P10	P10	P09	P10	P10	R/A
	P11	P12	P11	P12	P12	P12	P12	P12	P12	P12	RRR	HE1	P10	VGR	RRR	RRR	VG2	VG2	RRR	P12	P12	VGR	P11	VG2	RRR	RRR	P11	P11	
DSS-14	P12	VG2	P12	RRR				R/A	RRR	VG2				R/A	P12							P11							P12
	RRR							P12						P10								RRR							P12
	DSN	P12	ENG	ENG	ENG	P12	P12	DSN	P12	P12	P12	P11	P12	P11	P11	P11	VG1	P11	VG2	VG2	P12	VG1	VG2	VG2	P11	P11	P11	VG2	VG2
DSS-42	P11	VG2	P12					P11	VG1	VG1	P12	P12	P12	P12	P12	P12	P12	P12	P12	P12	P12	VG1	VG2	VG2	P12	P12	P12	P12	VG2
	P12							P12																					
DSS-43	P12	ENG	P12	VGR	R/A	R/A	DSN	R/A	P12	P12	R/A	R/A	P10	VGR	R/A	VG2	P12	R/A	R/A	R/A	R/A	R/A	R/A	R/A	P10	P10	P10	R/A	R/A
	VG1		VG2	VG2	P11	P09	ENG	P12	P12	VG2	VG2	VG2	VG2	P12	P12	VG1	VG2	P10	P12	P12	P11	VGR	P12	P12	VG2	VG2	P12	P12	P12
				VK1		P12	R/A	P12	VG2				P08									P12							
DSS-44	DSN	P11	VG1	P11	HE1	P11	P11	HE1	P11	P11	P11	DSN	P11	HE1	HE1	HE1	P11	HE1	P11	VG1	HE1	HE1	P11	P11	VG1	HE1	P11	HE1	VG1
	P11	HE1		P12	VG1	HE1	HE1	HE1	VG1	HE1	HE1	P11	HE1	VG1	VG1	VG1	HE1	HE1	HE1	VG1	VG1	HE1	HE1	HE1	HE1	HE1	HE1	VG1	
		HE1		HE1								HE1																	
DSS-61	VG1	DSN	P12	P12	VG2	P12	P12	DSN	P12	VG2	P12	VG2	P12	VG1	P12	P11	P12	VG2	P12	VG2	VG1	P12	P12	P12	P11	P12	VG2	P11	P12
		P11	VG2	VG1				P11	VG1		VG1				VG2	VG2	VG1	VG2	VG2	VG2	VG2	VG1	VG2	VG2	VG2	VG1	VG1	VG1	P12
DSS-62	P11	P12	DSN	R/A	P11	P12	VG1	VG1	DSN	P12	P11	P12	P12	R/A	P11	P12	P11	P12	VG1	VG1	P11	P11	P11	P12	VG1	P11	P12	VG1	VG1
	P12	VG1	VG1		P12	VG1			P11	VG1	P12	VG1	VG1	VG2		VG1						P12	P12	VG1					
DSS-63	P10	P10	VGR	ENG	P10	P09	ENG	ENG	P10	P10	ENG	P10	DSN	VGR	P10	P10	P10	P11	P09	P11	P10	VGR	P10	P10	P10	P06	ENG	ENG	R/A
	VG2	VG2	P10	P10	P11		DSN	P10	VG2	VG2	P10	P11	P11	P12	P12	P12	P12	P12	P12	P12	P12	P10	VG1	P12	P12	VG2	P10	P10	P10
				VG2	VG2		P06	P10	P10	P10	VG2	VG2	VG2		VG1	VG1	VG1	VK1				VG2	VG2	VG2	VG2	VG2	VG2	VG2	P12

Table 4. DSS Delta X-Chart (generated 2/13/81)

[illegible]

Table 5. DSN 10-week operations schedule for all stations, conflicts flagged (week no. 6, 3 Feb 81 – 9 Feb 81)

Line item	Day	Start-end	Facility	User	Activity	Pass no.	Pre-track hrs-min	AOS LOS	Post-track hrs-min	DSS config	Work category	DSN config	Conflict flag
(Sat. 7 Feb)													
455	38	0000-2400	DSS-12	DSS-12	Panel alignment		None	0000-2400	None	None	3A1	B700	
456	38	0025-0655	DSS-63	DSS-63	Maintenance		None	0025-0655	None	None	2A1	M700	
457	38	0035-0535	DSS-44	HEL-01	Tracking pass	2252	1 0	0135-0520	0 15	200063	1A1	I000	
458	38	0220-0820	DSS-11	DSS-11	Maintenance		None	0220-0820	None	None	2A1	A700	
459	38	0535-0825	DSS-44	PN-12	Tracking pass	995	0 30	0605-0755	0 30	800063	1A1	I000	
460	38	0650-1250	DSS-42	DSN	NEP RFI test		None	0650-1250	None	None	2C2	G700	
461	38	0650-1250	DSS-43	DSN	NEP RFI test		None	0650-1250	None	None	2C2	H700	
462	38	0655-1545	DSS-63	PN-12	Tracking pass	995	0 30	0725-1530	0 15	800063	1A1	M000	
463	38	0815-1250	DSS-43	DSS-43	Maintenance		None	0815-1250	None	None	2A1	H7C0	461
464	38	0820-1745	DSS-11	VGR-01	Tracking pass	1255	0 30	0850-1715	0 30	610063	1A1	A000	
465	38	1020-1520	DSS-61	DSS-61	Maintenance		None	1020-1520	None	None	2A1	K700	
466	38	1135-2250	DSS-44	VGR-02	Tracking pass	1271	1 0	1235-2220	0 30	610063	1A1	I000	
467	38	1250-2220	DSS-43	PN-11	Tracking pass	2872	0 30	1320-2205	0 15	000063	1A1	H000	
468	38	1540-2140	DSS-62	DSS-62	Maintenance		None	1540-2140	None	None	2A1	L700	

HISTORY — PLANNED

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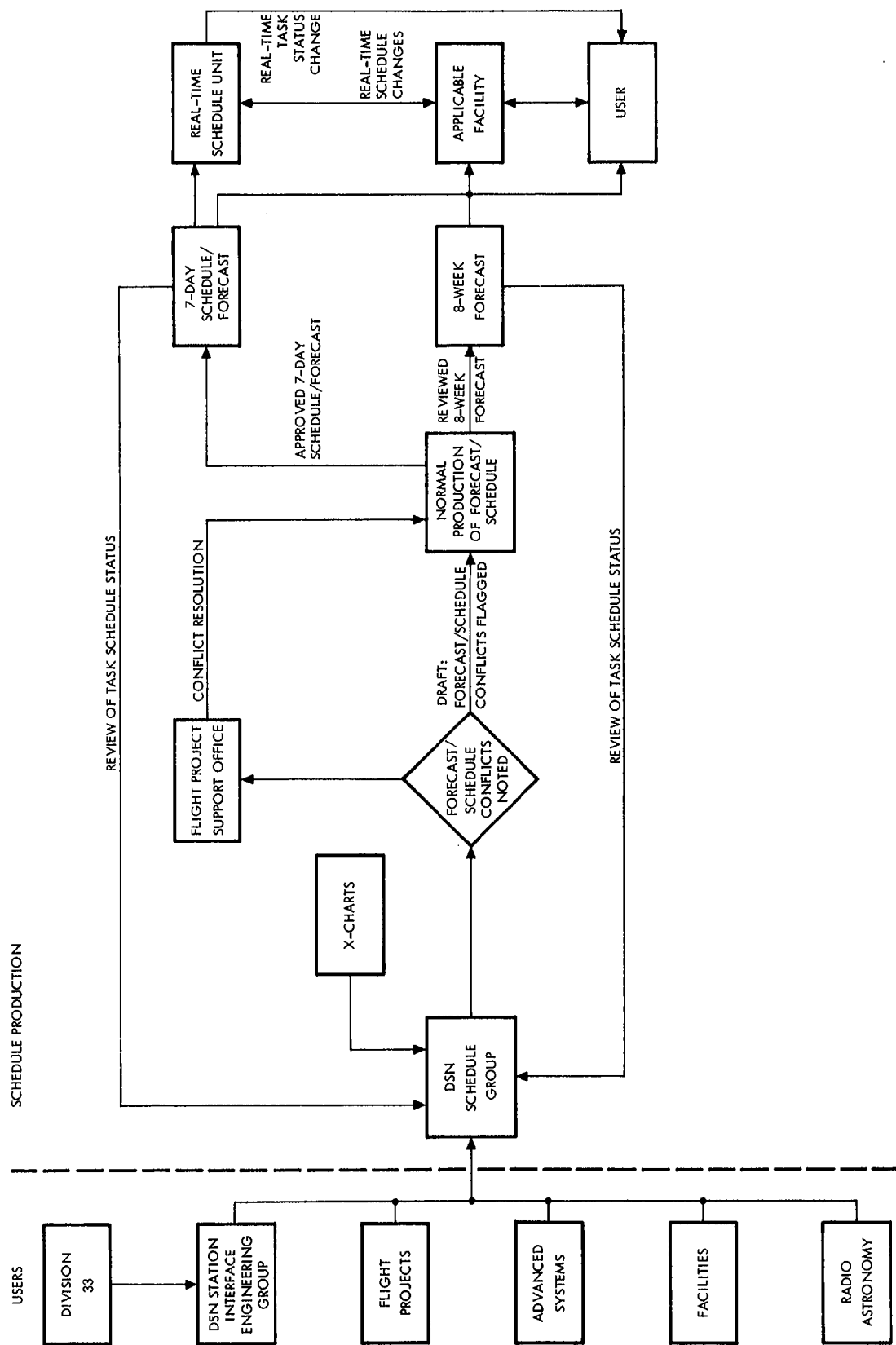


Fig. 2. Functional flowchart for scheduling